Theory of modularity limiting disturbance effects found to be sound using springtails

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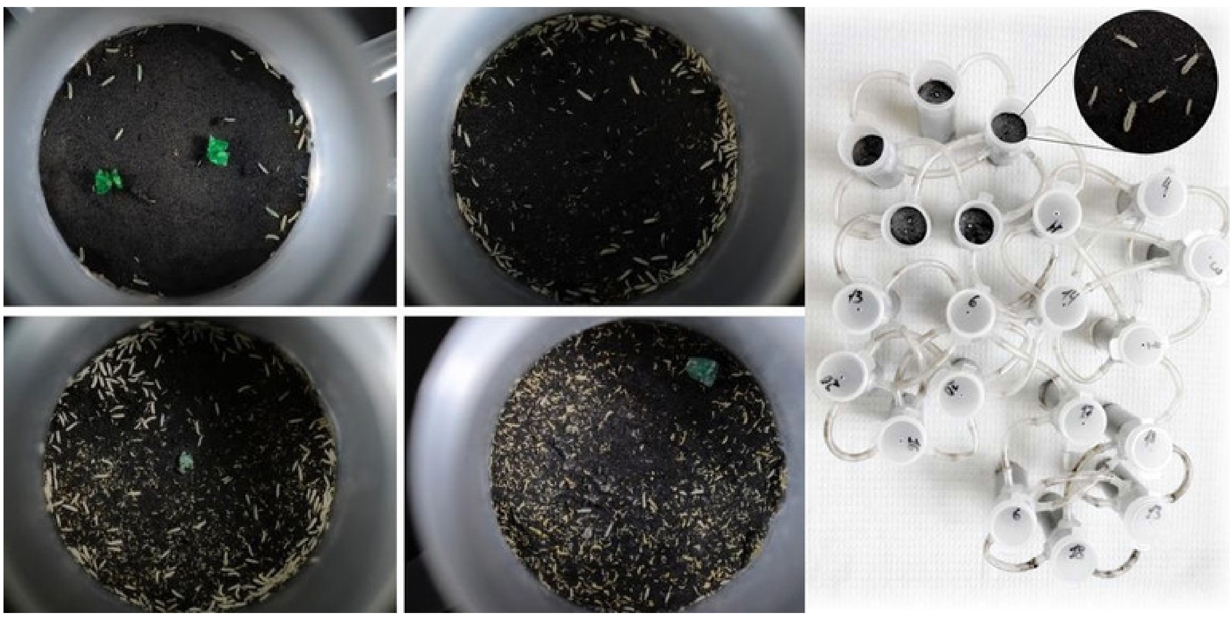

Experimental network (right) and four modules with different living conditions. Credit: Andrew Gonzalez, Luis J. Gilarranz et al./CSIC

(Phys.org)—A team of researchers from Spain, Switzerland and Canada has used common springtails to prove the soundness of a theory that suggests that modularity limits disturbance effects in networks. In their paper published in the journal *Science*, the group describes their experiments and what they observed. Marta Sales-Pardo with Universitat Rovira i Virgili offers a Perspective piece on the work done by the team in the same issue along with a short history of the theory behind the work and an explanation of why it matters in the modern world.

Many modern networks are built on the principle that networks that are made with a modular structure are less likely to experience global failure than are those that are not—the theory behind the principle has been around for some time. But as the researchers with this new effort note, the theory has never actually been tested in a real-world environment. Because of that, they looked to nature to provide a possible example.

To conduct their experiments, the researchers obtained samples of springtails (Folsomia candida), which are microarthropods that live in soil throughout the world. They were encouraged to multiply and inhabit patches (representing nodes) that were connected in a modular way. To allow the environment to truly resemble a network, the researchers made sure the tiny creatures were able to move between nodes. At the onset of the experiment, all of the nodes were populated with the same number of specimens, allowing the network to reach a stable point. Then, the researchers introduced a disturbance by simply removing specimens from nodes, one at a time. The team reports that doing so did not lead to population reductions in other nodes—the modular nature of the network offered a buffer of protection, preventing extinction of the network as a whole. According to researchers, the natural network offered evidence suggesting that the original theory appears to be correct.

The researchers found something else too, the stability provided by noded modules came at a cost—reductions in population growth. But as with real networks, it would appear the benefit of added protection for the network as a whole is well worth cost of slowed growth.

More information: Effects of network modularity on the spread of perturbation impact in experimental metapopulations, *Science* 14 Jul

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Abstract
Networks with a modular structure are expected to have a lower risk of global failure. However, this theoretical result has remained untested until now. We used an experimental microarthropod metapopulation to test the effect of modularity on the response to perturbation. We perturbed one local population and measured the spread of the impact of this perturbation, both within and between modules. Our results show the buffering capacity of modular networks. To assess the generality of our findings, we then analyzed a dynamical model of our system. We show that in the absence of perturbations, modularity is negatively correlated with metapopulation size. However, even when a small local perturbation occurs, this negative effect is offset by a buffering effect that protects the majority of the nodes from the perturbation.